Journal of
Plant Sciences

ISSN 1816-4951

Academic
Journals Inc.

www.academicjournals.com

Journal of Plant Sciences 2 (4): 440-446, 2007
ISSN 1816-4951

Macroelement (N, P, K) Contents of *Romulea columnae* Seb. and Mauri Subsp. *columnae* During Vegetative and Generative Growth Phases

[1]Tuğba Kök, [2]Ali Bilgin, [3]Canan Özdemir, [4]Hamdi Güray Kutbay and [4]Mustafa Keskin
[1]Canik Anadolu High School-Samsun/Turkey
[2]Department of Biology, Faculty of Science and Arts,
University of Rize, Rize/Turkey
[3]Department of Biology, Faculty of Science and Arts,
University of Celal Bayar, Manisa/Turkey
[4]Department of Biology, Faculty of Science and Arts,
University of Ondokuz Mayis, 55139, Kurupelit-Samsun/Turkey

Abstract: *Romulea columnae* Seb. and Mauri subsp. *columnae* is a geophytic plant belonging to Iridaceae. In this study nitrogen (N), phosphorus (P) and potassium (K) analysis were carried out during vegetative and generative growth periods. It has been found that above ground parts of plant have higher macroelement concentrations as compared to below ground parts during vegetative growth period. However, below ground parts have higher macroelement concentrations during generative growth phase due merely to top senescence. In addition to this there were significant and mostly negative correlations between plant and soil macroelement concentrations.

Key words: *Romulea columnae* seb. and Mauri subsp. *columnae*, macroelement content, plant-soil relationship, vegetative growth period, generative growth period

INTRODUCTION

Geophytic plants evade stress conditions such as shade, drought etc., by survival in below ground organs and they exhibit, hereby, some features of sun plants but also those of plants shaded habitats (Goryshina, 1972). Geophytes are the plants in which the perennating bud is borne on a subterranean storage organ and their annual growth cycle usually includes a dormant period. The reserves in geophytic plants in their storage organ support leaf growth at the beginning of the growing season and to a varying degree, also reproduction. They also classified as spring ephemerals (Méndez, 1999; Lapointe, 2001). Spring ephemerals have a very short epigeous (period during which shoots are present above ground) growth period of 40-60 days in spring (Lapointe, 2001; Kilinc *et al*., 2005). In addition to this they have also interesting phenological properties such as flowering time (spring or autumn), the presence of protantherous and hysteranthous taxa etc., (Rawal *et al*., 1991; Feller and Fischer, 1994).

Romulea columnae Seb. and Mauri subsp. *columnae* is a spring geophyte belonging to Iridaceae and it is a Mediterranean element and it is a new record for the study area (A6 square) according to the grid system of Davis (1984). This species widely used as an ornamental plant. It consists of some alkaloids in its bulbs most of them are not clearly identified (Baytop, 1984). So, that the bulbs of this taxa have continuously been exporting to the abroad so that population density of this taxa have been decreased day by day (Ekim *et al*., 2000).

In this study the redistribution of some macroelements (N, P, K) between above and below ground parts and the correlations between plant and soil during vegetative and generative growth

Corresponding Author: Ali Bilgin, Department of Biology, Faculty of Science and Arts, University of Rize, Rize/Turkey

periods were examined to determine whether this species followed the same pattern with the other spring ephemerals in terms of macronutrient using strategy (i.e., top senescence phenomena) or not. The concentrations of nitrogen, phosphorus and potassium seem to be more closely controlled than other nutrients, which could reflect the specific amounts needed for biochemical function (Canadell and Vilà, 1992).

MATERIALS AND METHODS

Study Area

This study was carried out around Kurupelit region, near Bafra town which is situated in the northern part of Turkey (36° 10' E, 41° 22' N) in 2001. Plant individuals were taken from open grassy places in a maquis community dominated by *Phillyrea latifolia* L. at 150 m. The plants are densely occured in this region. Outside this region plants were scattered due to urbanization and overgrazing (Ekim *et al*., 2000).

Mean annual temperature and mean annual precipitation in the study area are 14.3°C and 712 mm, respectively. A xeric period which is one of the main indicators of Mediterranean climate (Daget, 1977) was observed from June to September in the study area. According to the Emberger's precipitation-temperature formula ([$Q = 2000 \times P/(M+m+546.4)(M-m)$] where Q is the precipitation-temperature index; M is maximum temperature and m is minimum temperature, respectively) Q, M and m values are 129.3, 23.2 and 4.0° C, respectively and the climate of the study area is humid Mediterranean (Daget, 1977; Ministry of Agriculture, 1994).

Ten plant individuals used for macroelement analysis in each of vegetative and generative growth phases. In other words, sampling was repeated twice during vegetative and generative growth phases. Phenological observations were also recorded.

Method of Chemical Analysis

Plant samples were harvested during vegetative and generative growth phases and separated into above and below ground parts. After being washed in deionized water the plant parts were dried at 70°C to the constant weight and grounded in a Wiley mill and pass through a 20 mesh sieve. Nitrogen was determined by the micro Kjeldahl method with a Kjeltec 1030 Analyser (Tecator, Sweden) after digesting the samples in concentrated H_2SO_4 with a selenium catalyst. For P and K analysis plant specimens were wet ashed in concentrated HNO_3 and $HClO_4$ and P was determined by using Jenway spectrophotometer and K was determined by Petracourt PFP-7 flame photometer (Allen *et al*., 1986).

Soil samples were collected during vegetative and generative growth phases separately and soil and plant samples were taken simultaneously during vegetative and generative growth phases. Soil samples were taken using a 7 cm diameter auger to a depth of 30 cm. Ten soil cores were taken according to a fixed spatial arrangement after the plant samples removed. Soil samples were air-dried and sieved to pass through a 2 mm. mesh prior to analysis. Soil texture was determined by Bouyoucous hydrometer method. pH values were measured in deionized water (1:1). Total salinity (%) was determined by conductivity bridge apparatus. Soil nitrogen (%) was determined by micro Kjeldahl method. Soil phosphorus (%) was determined spectrophotometrically following the extraction by ammonium acetate. Soil potassium (%) was determined by using a Petracourt PFP-7 flame photometer after nitric acid wet digestion. Organic matter (%) and $CaCO_3$ (%) concentrations were determined by Walkley-Black method and Scheibler calcimeter respectively (Bayrakli, 1987). The results of soil analysis were explained according to Chapmann and Pratt (1973) and Bayrakli (1987).

The differences were assessed by one-way ANOVA test. Pearson correlation coefficients were also calculated. Statistical analysis were performed using MINITAB software package (Schaefer and Anderson, 1989).

RESULTS

Phenological Observations

Romulea columnae subsp. *columnae* is a protantherous taxa and leaves appeared before the flowers. Leaves were appeared at the end of February. The flowering time of *R. columnae* subsp. *columnae* is the second half of March. In other words, *R. columnae* subsp. *columnae* sharply switches from vegetative to reproductive growth. The appearance of fruits takes place at the second half of April and at the first half of May the seeds are dispersed.

The Results of Plant and Soil Analysis

Romulea columnae subsp. *columnae* occur on clay loamy soils. Soil N and K concentrations were medium levels. However soil P concentrations were low levels. *Romulea columnae* subsp. *columnae* grow on non-calcerous and non-saline soils. Soil pH was slightly acidic during vegetative growth phase, however neutral during generative growth phase. Organic matter levels were high in both growth periods. (Table 1). Soil N, P and K were decreased during generative growth phase. However, soil organic matter, soil pH and $CaCO_3$ were increased during generative growth phase (Table 1).

Macroelement concentrations of above and below ground parts of *R. columnae* subsp. *columnae* during vegetative and generative growth phases were shown in Table 3 and 4. In vegetative growth period above ground parts have higher nutrient concentrations as compared to below ground parts However, below ground parts have higher nutrient concentrations during generative growth phase inversely (Table 3 and 4).

Table 1: Mean values for soil parameters

Soil parameter	n	Growth period	Mean values
N	10	Vegetative	0.48±0.06
N	10	Generative	0.29±0.04
P	10	Vegetative	4.20±0.01
P	10	Generative	2.00±0.004
K	10	Vegetative	0.55±0.10
K	10	Generative	0.31±0.02
Organic matter	10	Vegetative	4.37±0.50
Organic matter	10	Generative	7.73±1.36
pH	10	Vegetative	6.18±0.07
pH	10	Generative	6.95±0.17
$CaCO_3$	10	Vegetative	0.39±0.07
$CaCO_3$	10	Generative	1.38±0.72
Total salinity	10	Vegetative	0.05±0.006
Total salinity	10	Generative	0.07±0.006

Table 2: The comparison between vegetative and generative growth periods in respect to soil factors

Soil parameter	n	F-value	Probability	Significance
N	10	7.15	.028	*
P	10	3.90	.084	NS
K	10	5.25	.051	NS
Organic matter	10	5.35	.049	*
pH	10	17.88	.003	**
$CaCO_3$	10	1.89	.206	NS
Total salinity	10	6.54	.034	*

*: p< 05; **: p< 01; NS: Not Significant

Table 3: Above ground macro element concentrations during vegetative and generative growth phase

Growth phase	Element	n	Mean values
Vegetative	N	10	1.38±0.22
Vegetative	P	10	0.28±0.01
Vegetative	K	10	0.56±0.10
Generative	N	10	0.95±0.20
Generative	P	10	0.10±0.03
Generative	K	10	0.16±0.03

Table 4: Below ground macroelement concentrations during vegetative and generative growth phases

Growth phase	Element	n	Mean values
Vegetative	N	10	0.65±0.16
Vegetative	P	10	0.10±0.02
Vegetative	K	10	0.14±0.01
Generative	N	10	1.68±0.14
Generative	P	10	0.23±0.02
Generative	K	10	0.54±0.11

Table 5: Statistical comparison of above and below ground macroelement concentrations

Growth phase	Element	N	F-value	Probability	Significance
Vegetative	N	10	7.504	.038	*
Generative	N	10	8.741	.042	*
Vegetative	P	10	79.445	.001	**
Generative	P	10	10.955	.016	*
Vegetative	K	10	16.953	.015	*
Generative	K	10	13.598	.021	*

*:p< 05; **: p< 01

There were significant differences between above and below ground macroelement concentrations both vegetative and generative growth phases (Table 5). There were also significant and mostly negative correlations between plant and soil macroelement concentrations in above and below ground parts in both growth periods.

DISCUSSION

There were significant differences between two growth periods in respect to soil N concentration, organic matter, pH and total salinity. The other soil factors were not significantly changed (Table 2). Soil pH and organic matter were inherently interrelated (Goldberg 1982). Increasing in pH during generative growth phase were related to the return of dead organic matter consists of basic materials to the surface of the soil (Singh, 1989).

Macroelement concentrations in above ground parts of *R. columnae* subsp. *columnae* are higher than below ground parts during vegetative growth phase (Table 3 and 4) due to the fast division of meristematic cells in above ground parts. High nitrogen concentrations in meristematic tissues were depend on the high protein content of that tissues (Werger and Hirose, 1991; Moorby and Beresford 1983). However, in generative growth period below ground parts have higher nutrient concentrations as compared to above ground parts. Anderson and Eickmeier (2000) reported that many species resorb nutrients from their above ground parts back to below ground parts during senescence and the transfer of nutrients is often associated with soil nutrient availability. During the epigeous growth period, spring ephemerals accumulate mineral nutrients in their below ground organs and develop the buds for the next year's growth. Dormancy is broken in autumn with bud and below ground growth that continues throughout the winter at a very slow pace, due to low soil temperatures and this growth period is called hypogeous growth, as it occurs below ground (Lapointe, 2001; Kilinc *et al*., 2005).

Similar results were also obtained in several other studies on geophytic plants (Pirdal, 1989; Kutbay and Kilinç, 1993; Kutbay and Kilinç, 1995; Sahin 1998; Kutbay 1999). This situation is known as top senescence (Leopold, 1980). In such plants the above ground parts senesce completely and new shoots appear at the beginning of the next season. The reserves in the vegetative storage organs allow a rapid growth during initial phase (Steinmann and Brandle, 1984; Nooden, 1984; Berchtold *et al*., 1993). Senescence is an important process in the adaptation of higher plants to environmental conditions. This is a well controlled process and it is not a passive decay of a plant (Feller and Fischer, 1994). Senescence is allowed to the optimum usage of macroelements for a plant (Jayasekera, 1993).

Table 6: Pearson correlation coefficients between plant and soil macro element concentrations in above ground parts

Growth phase	Element	n	Correlation coefficient	Significance
Vegetative	N	10	-0.602	**
Generative	N	10	0.192	NS
Vegetative	P	10	-0.838	**
Generative	P	10	-0.943	**
Vegetative	K	10	-0.994	**
Generative	K	10	-0.997	**

** p< 01; NS: Not Significant

Table 7: Pearson correlation coefficients between plant and soil macro element concentrations in below ground parts

Growth phase	Element	n	Correlation coefficient	Significance
Vegetative	N	10	-0.698	**
Generative	N	10	-0.940	**
Vegetative	P	10	-0.188	NS
Generative	P	10	-0.291	NS
Vegetative	K	10	-0.684	**
Generative	K	10	-0.516	*

* p< 05; ** p<01; NS:Not Significant

In addition to the top senescence monocotyledonous herbs have also adaptive advantages as compared to dicotyledonous herbs. For example, above ground parts of monocotyledonous herbs develop their leaves from a basal meristem. However, dicotyledonous herbs develop their leaves from an apical meristem. As a result of this meristematic tissues are at ground level in monocotyledonous herbs. This means that the benefit of a basal meristem at ground level, in terms of effective using of macroelements especially nitrogen, rapid transfer of nutrients between above and below ground parts, providing protection against damage through grazing, fire etc., (Werger and Hirose, 1991).

Canadell and Vilà (1992) found significant and negative correlation coefficients between plant and soil nutrients. Knops and Koenig (1997) found positive significant correlations between soil nitrogen and phosphorus and foliar nitrogen and phosphorus. Powers (1984) and Johnson *et al*. (1987) also found positive correlation coefficients between soil and plant nutrient levels. Mostly negative correlation coefficients were obtained between plant and soil macroelement concentrations in above and below ground parts of *R. columnae* subsp. *columnae* (Table 6 and 7).

These results suggest that soil nitrogen, phosphorus and potassium may influence plant nutrient levels in most plants. However, there was species-specific differences in this respect. Ecosystems dominated by short or long-lived species develop soil over a multi-generational influencing soil to a small but eventually important degree (Knops and Koenig 1997). Top senescence is an important strategy to the adaptation of geophytic plants to environmental conditions and main aim of this strategy is effective using of nutrients. The results of the present study can be evaluated in cultivation of *R.columnae* subsp. *columnae*. Future research should focus on top senescence in geophytic plants to a more precise explanation the nutrient patterns during vegetative and generative growth phases.

REFERENCES

Allen, S.E., H.M. Grimshaw, J.A. Parkinson, C. Quarmby and J.D. Roberts, 1986. Chemical Analysis. In: Methods in Plant Ecology. Chapman, S.B. (Ed.), Blackwell Scientific Publications, Oxford, pp: 411-466.

Anderson, W. and W.G. Eickmeier, 2000. Nutrient resorption in *Claytonia virginica* L: Implications for deciduous forest nutrient cycling. Can. J. Bot., 78: 832-839.

Bayrakli, F., 1987. Plant and soil analysis. University of Ondokuz Mayis, Faculty of Agriculture Publications, Samsun, pp: 199.

Baytop, T., 1984. Phytotherapy in Turkey From Past to Future. Istanbul University, Department of Pharmacy Publications, Istanbul, pp: 520.

Berchtold, A., J.M. Besson and U. Feller, 1993. Effects of fertilization levels in two farming systems on senescence and nutrient contents in potato leaves. Plant and Soil, 78: 779-783.

Canadell, J. and M. Vilà, 1992. Variation in tissue element concentration in *Quercus ilex* L. over a range of different soils. Vegetatio, 99: 273-282.

Chapmann, H.D. and P.F. Pratt, 1973. Methods of analysis for soils, plants and waters. University of California Press. California.

Davis, P.H., 1984. Flora of Turkey and the East Aegean Islands. Vol. VIII, Edinburgh University Press. Edinburgh.

Daget, P.H., 1977. Mediterranean bioclimate: Analysing of climate types according to the Emberger system. Vegetatio, 34: 87-103.

Ekim, T., M. Koyuncu, H. Duman, Z. Aytaç and N. Adigüzel, 2000. Red Data Book of Turkish Plants (Pteridophyta and Spermatophyta). Turkish Association for the Conservation of Nature, Ankara, pp: 246.

Feller, U. and A. Fischer, 1994. Nitrogen metabolism in senescing leaves. Critical Rev. Plant Sci., 13: 241-273.

Goldberg, D.E., 1982. The distribution of evergreen and deciduous trees relative to soil type: An example from the Sierra Madre, Mexico and a general model. Ecology, 63: 942-951.

Goryshina, T.K., 1972. Ecophysiological investigations on ephemeroid plants in forest-steppe zone of Central Russia. Oecol. Plant., 7: 241-258.

Jayasekera, R., 1993. Interelement relationships in leaves of tropical montane trees. Vegetatio, 109: 145-151.

Johnson, J.E., C.L. Haag, J.G. Bockheim and G.G. Erdmann, 1987. Soil-site relationships and soil characteristics associated with even-aged red maple (*Acer rubrum*) stands in Wisconsin and Michigan. Forest Ecol. Man., 21: 75-89.

Kilinc, M., A. Bilgin, E. Yalcin and H.G. Kutbay, 2005. Macroelement (N, P, K) contents of *Arum euxinum* R. Mill during vegetative and generative growth phases. Pak. J. Biol. Sci., 8: 267-272.

Knops, J.M.H. and W.D. Koenig, 1997. Soil fertility and leaf nutrients of sympatric evergreen and deciduous species of *Quercus* in central coastal California. Plant Ecol., 130: 121-131.

Kutbay, H.G. and M. Kilinç, 1993. An autecological study on *Leucojum aestivum* L. Turk. J. Bot., 17: 1-4.

Kutbay, H.G. and M. Kilinç, 1995. An autecological study on *Galanthus rizehensis* Stern (Amaryllidaceae) Turk. J. Bot., 19: 235-240.

Kutbay, H.G., 1999. Top senescence in *Sternbergia lutea* (L.) Ker-Gawl ex Sprengel and *Narcissus tazetta* L. subsp. *tazetta.* Turk. J. Bot., 23: 127-131.

Lapointe, L., 2001. How phenology influences physiology in deciduous forest spring ephemerals. Physiol. Plant., 113: 151-157.

Leopold, A.C., 1980. Ageing and Senescence in Plant Development. Thimann, K.V. (Ed.), Senescence in Plants CRC Press. California.

Méndez, M., 1999. Effects of sexual reproduction on growth and vegetative propagation in the perennial geophyte *Arum italicum* (Araceae). Plant Biol., 1: 115-120.

Ministry of Agriculture, 1994. Mean and Extreme Temperature and Rainfall Values. General Directorate of Meteorology Ankara.

Moorby, J. and R.T. Beresford, 1983. Mineral Nutrition and Growth. In: Encylopedia of Plant Physiology. Lauchli, A. and R.L. Bieleski (Eds.), Springer Publications. Berlin, pp: 481-527.

Nooden, L.D., 1984. Integration of soybean pod development and monocarpic senescence. Physiol. Plant., 62: 273-284.

Pirdal, M., 1989. An autecological study on *Asphodelus aestivus* Brot. Turk. J. Bot., 13: 89-101.

Powers, R.F., 1984. Estimating Soil Nitrogen Availability Through Soil and Foliar Analysis. In: Forest Soils and Treatment Impacts. Stone, E.L. (Ed.), Knoxville, Tennessee, pp: 353-379.

Rawal, R.S., N.S. Bankoti, S.S., Samant and Y.P.S. Pangtey, 1991. Phenology of tree layer species from the timber line around Kumaun in Central Himalaya, India Vegetatio, 93: 109-118.

Sahin, N.F., 1998. Morphological, anatomical and physiological studies on *Galanthus ikariae* Baker and *Galanthus rizehensis* Stern (Amaryllidaceae) grown around NE Turkey Pak. J. Bot., 30: 117-131.

Schaefer, R.L. and R.B. Anderson, 1989. The student edition of MINITAB,User' s Manual Addison Wesley Publishing Company Inc., New York.

Singh, L., 1989. Dry matter and nutrient inputs through litter fall in a dry tropical forest of India. Vegetatio, 98: 129-140.

Steinmann, F. and R. Brandle, 1984. Carbohydrate and protein metabolism in the rhizomes of bulrush (*Schoenoplectus lacustris* (L.) Palla) in relation to natural development of the whole plant. Aquatic Bota., 19: 53-63.

Werger, M.J.A. and T. Hirose, 1991. Leaf nitrogen distribution and whole canopy photosynthetic carbon gain in herbaceous stands. Vegetatio, 97: 11-20.